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Dry-Rot in Buildings and Stored Construction Materials and How to Combat It

By

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Dry-rot due to *Poria incrassata* in Southern Yellow Pine.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS, THE ALABAMA POLYTECHNIC INSTITUTE AND THE UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING—ACTS OF MAY EIGHTH AND JUNE THIRTIETH, NINETEEN HUNDRED FOURTEEN.

DRY-ROT IN BUILDINGS AND STORED CONSTRUCTION MATERIALS AND HOW TO COMBAT IT

By

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Dry-rot has become a serious menace to the lumberman and builder in Alabama as well as in other Southern states and on the Pacific coast. It appears to be on the increase and is causing very heavy losses throughout the infested regions. The destruction has reached such proportions that if timber is to maintain its high standard of usefulness as a structural material, the plague must be effectively controlled. Fortunately, dry-rot in new structures can easily be prevented, and at little expense. In buildings already infected, while the remedy is plain, the expense is often considerable.

WHY DOES TIMBER DECAY?

All wood rots are due to fungous growths on or within the timber. These may be cobwebby or cottony or in the form of thin paper sheets on the surface of the wood, in cracks in the timber, or at construction joints. Under the microscope they are seen to be composed of minute, branched, interwoven threads. It is these threads (collectively termed *mycelium*) which feed upon the wood and disintegrate it.

In addition to the mycelium the fungus may also produce what we term *fruit-bodies*. These vary in shape and appearance for the different wood-destroying fungi. Some may be shelving conchs or brackets, others may resemble the common mushrooms or toadstools and still others may simply form fleshy to leathery incrustations on the surface of the timber. The purpose of the fruit bodies is to produce *spores,* which take the place of seeds in higher plants. Fungus spores are microscopic in size, very abundant, very light, and hence easily wafted about by air currents.

Wood may therefore become infected either by *mycelium* or *spores*. If placed in contact with decaying timber the threads will grow directly from the infected stick to the sound one, and in a moist atmosphere they may even overgrow inert substances

like rock and masonry and reach sound wood some distance away. When wood is placed in contact with the ground the infection comes directly from the soil, which apparently harbors many of our most destructive fungi. Spore infections can take place over considerable distances. When fresh spores settle on moist wood they germinate just as do seeds in warm moist soil and produce the mats of threads just mentioned.

WHAT IS DRY-ROT?

The term dry-rot is often applied by the layman to all kinds of wood decay where the timber ultimately becomes dry and crumbly, but since that condition is a characteristic also of very many fungi of comparatively minor economic importance the particularly descriptive term should be limited to those more virulent organisms which, on account of the development of a special water-conducting system, cause us the gravest concern because of their more rapid action.

The true dry-rot fungi are provided with porous, root-like strands which carry water from moist areas at or near the ground to the dry timber above. The timbers seem to rot while in a *dry* condition, whereas in reality they are first moistened by the water conducted to them.

All timber must be moist before it will decay and, hence, *all dry-rot infections start where the timber has been subjected to considerable moisture.* This conclusion is borne out by every dry-rot infection that the writers have inspected.

There are a very limited number of dry-rot fungi in Alabama and neighboring states, the most important being *Poria incrassata* and certain brown species of *Merulius.* The former species is by far the most important and is almost invariably associated with the more severe cases of rot reported. The discussion will therefore be confined principally to the *Poria,* since the precautions to be taken against infection and the remedies to be applied after infection are essentially the same for all dry-rot fungi.

DISTRIBUTION OF *PORIA INCRASSATA* IN ALABAMA

Poria incrassata is widely distributed throughout the State, being very prevalent in residences, store and office buildings, churches, lumber sheds, etc. The senior author first observed the disease in Alabama in 1914, when he was called upon to assist in the eradication of two serious infections in lumber sheds. Reports of the trouble have continued to come in and during the past year Mr. I. T. Quinn, State Conservation Commissioner, requested the U. S. Department of Agriculture and the Alabama Experiment Station to make a brief survey of present conditions in the State. This survey was made during June, 1923. The present report contains the results of that investigation as well as other observations.

The disease is now known to occur in at least thirteen widely separated cities and towns in Alabama and is likely to be found at any point in the State. Thirty-six different cases have been personally investigated. Of these, twelve occurred in residences, eleven in lumber storage sheds, five in churches, five in stores and office buildings, and three in outbuildings. The trouble is particularly severe in the southern half of the State and the situation has become very serious on account of the considerable number of outbreaks in lumber yards. In Mobile alone one contractor devotes his entire time to the repair of buildings partially destroyed by dry-rot. He states that he knows of hundreds of cases in that city, many of which he has himself repaired.

HOW TO DISTINGUISH THE FUNGUS

Poria incrassata is quite easily recognized in its various stages of development (Pl. I) and exhibits certain peculiarities in its attack on buildings (Pls. II and III). Always starting in basements or beneath the first floor, it first appears as papery, often fan-shaped, sheets of mycelium which are whitish with a distinct yellowish tinge (Pl. I, Fig. 3). These may coat any timbers surrounded by moist atmosphere, particularly those covered by sheathing, plaster, etc. The subfloor timbers are, naturally, first attacked and sheets of the mycelium form between the subfloor and the top floor (Pl. II, Fig. 5). From the first floor the infection rapidly runs up the walls of frame buildings (Pl. II, Fig. 4), sometimes for 20 to 25 feet. The interior finish, such as door and window casings, wainscoating, (Pl. II, Fig. 3), ceiling lumber forming simple partitions, etc., soon gives evidence of the destruction going on within the walls by a hollow sound on tapping and by shrinkage and separation of the boards (Pl. III, Figs. 4 and 5) sufficient to show the whitish fungus mycelium behind.

If a careful examination is made beneath the floors when the disease is first noticed, irregular vine-like or root-like growths (Pl. II, Fig. 1) which may be dirty whitish, sometimes yellowish tinged, or even olive-brown will very often be found coming directly from the ground, or from woody refuse on the ground, to the timber. These are the water-conducting organs, of which the outside layers consist of compactly interwoven fungous threads and the interior contains numerous minute tubes, invisible to the naked eye, which carry water upward from the soil. These growths may reach the size of one's wrist. Sometimes they develop as heavy flattened "veins" (Pl. I, Fig. 10) on the under surface of flooring, and in that case they are usually closely attached to the wood, olive-brown in color and embedded in sheets of mycelium.

The stages in the growth of the fungus thus far discussed are sterile, that is, they do not produce spores. At times one also

finds the spore-bearing stage (fruit bodies) (Pl. I, Figs. 1, 2, 4, 6, 7 and 8) forming on the surface of the timber. These are always in the form of crusts, which when developed may become half an inch thick. When growing on the under side of floors in darkness the fresh fruit bodies are fleshy and succulent in consistency and pale olive-gray with a dirty white to pale yellowish margin (Pl. I, Figs. 1 and 2). The surface is poroid, and when the crust is broken by bending sharply, the interior is seen to be composed of closely arranged vertical pores or tubes. As the plant ages and dries it turns brown or brownish-black (Pl. I, Figs. 4, 6 and 7) and ultimately becomes so brittle as to be easily pulverized between the fingers.

Fig. 1. Lumber storage shed in Alabama with no ventilation beneath the stock. A severe dry-rot outbreak occurred in this shed. (See Fig. 5.)

When the fungus grows in weak light, such as on foundation timbers in lumber sheds, in partially illuminated basements, on the upper surface of flooring, etc., the fruit bodies may show distinct orange shades (Pl. I, Fig. 8) over the younger portions and the mycelium may likewise be orange in color (Pl. I, Fig. 5). The spores (Pl. I, Fig. 9) are dusky olive.

The odor of slippery elm bark given off by dried fruit bodies is quite characteristic.

LOSSES DUE TO DRY-ROT IN ALABAMA

The brief survey of conditions so far made has demonstrated a great many infections throughout the State with the certainty of many more which have not come to our attention.

Damages to property in the less important cases may amount to only $300 to $500, but there are many instances ranging between $1500 and $3000, with a number above the latter figure. One repair job in a residence is reported to have cost $12,000. In large structures, such as churches, extensive repairs are often necessary. One church now under investigation shows considerable infection throughout with severe damage to a valuable pipe organ, installed two and one-half years ago, as well as destruction of the chamber in which it was housed. Necessary repairs will approach $10,000. Two other large churches which appear on superficial inspection to be hot-beds of dry-rot are under observation.

The rapidity with which dry-rot may develop is startling. A contractor in Mobile reports an instance where forming left under a new porch decayed in 9 months and the rot spread somewhat into the building. In another instance, where a glassed-in room was added to a residence, a leaky built-in gutter caused the floor to rot out in 6 months, and when repaired it rotted again in 3 months. Several cases are on record where fine residences but 2 to 3 years old have suffered heavily. Damage to structures 4 to 5 years old is very common. Stucco buildings in the South have given considerable trouble since the stucco often extends to the ground without any provision for ventilation. It is also quite permeable to water.

Damages to life and limb are fortunately rare. In one case it is reported that the floor gave way under a patient in a dentist's office but without serious consequences. In another instance the collapse of a porch at a church entrance caused injury to one of the members, at a cost of about $1000 for medical attendance. In churches, stores, and halls where the public may congregate the possible collapse of floors is a matter for earnest consideration.

The money loss from dry rot in Alabama is tremendous in the aggregate. As far as actual cost figures and estimates can be given for the cases thus far reported the resulting damage has cost property owners of the State around $200,000. Since the records cover but fifteen towns and cities and represent less than one-half of 1 percent of the municipalities in the State, it is conservative to assume that not five percent of the cases within the State have come to our attention. On this basis the probable loss runs up to several millions.

In addition to the cost of labor and material used in making repairs there are losses in merchandise and household effects within infected buildings, losses in stored lumber stocks and accessories, losses in rentals, losses incident to the interruption

of business, losses from injuries sustained in the collapse of floors, and the general inconveniences attending repair operations. When the picture is complete we can not do otherwise than consider dry-rot a distinct scourge which, so long as current conditions and practices prevail, threatens the present properties in the state as well as the prospective.

WHERE DOES THE RESPONSIBILITY FOR THIS CONDITION REST?

In this modern industrial age science is too firmly established to throw our human failings back upon a Divine Providence. The simple fact is that *timber decays because it is not properly handled, or properly used, or suitably protected.* The lumberman, the architect, the contractor, and the owner all share in the responsibility. With the right cooperation among all concerned dry-rot would soon disappear from the State. Let us see what the various interests can and should do towards clearing the situation.

Fig. 2. The dry-rot fungus, *Poria incrassata,* in the foundations and running up the post of an open shed in southern Alabama.

THE LUMBERMAN

Upon the lumberman rests the heavy obligation of taking such steps in the handling of his stock as shall insure delivery to the consumer of all lumber, timber, and other building materials *absolutely free from every trace of infection with dry-rot fungi.*

What is the present condition of many lumber sheds and other structures for the storage of builders' supplies? First, it can be said without equivocation, that a considerable number of dry-rot infections and outbreaks (Figs. 1 to 6), some of comparatively long standing, have been found in them; second, many others in which such infections have not been found are in such condition that they are readily susceptible to infection at any time.

We know that infected stock is being, or has been, sold in the State for building purposes (Pl. III, Fig. 7). Such material has sometimes been dressed to "brighten" it and to remove the conspicuous evidences of infection; but dry-rot fungi bite deeper than the planer knives and the process is only a dangerous subterfuge. It is only fair to suppose, however, that this and similar practices have been carried out without a full knowledge of the consequences likely to result.

When dry rot gets into a storage shed it may spread with great rapidity, rotting foundation timbers, flooring, posts and everything in its path. Diseased floors (Figs. 3 and 4) and foundations (Fig. 2) are, in fact, the principal source of infection for the stock (Figs. 7, 8 and 9). The organism will run up the posts in some instances for 12 to 14 feet. If the lumber is horizontally piled the rot progresses from the lower layers upward, except where a stack may be piled closely against an infected post (Fig. 5), in which case the adjoining lumber may all be infected at practically the same time as far as the disease in the post extends. When lumber is end-piled on diseased floors every piece of it may quickly take the infection by direct contact.

Other building materials may take the infection just as readily. Asphalt shingles and building papers may be destroyed. Tarred roofing may be rotted at the ends in contact with a decayed floor. Crates of sash (Fig. 10) may be permeated by the organisms. Nail kegs on opening may show dense mats of fungus threads covering the nails. Boxes of hardware may be found heavily matted by the growth, both within and without. It is also known to invade valuable electrical instruments, stored documents and stationery, to discolor and warp cement-asbestos shingles (Fig. 11), and to attack wire fencing, which it depreciates in sale value apparently by its acid action on the galvanizing coat. In fact almost anything with which it may come in contact will be deteriorated.

The ability of the fungus to attack practically all the different kinds of wood in the United States, heartwood as well as sapwood, and its capacity of invading air-dry as well as kiln-dried stock make it a particularly dangerous enemy to the lumberman and dealer in the South and Pacific Northwest.

Fig. 3. Lumber piled on a floor infected with dry-rot. Note the white areas of fungus mycelium on the surface of the floor. Lumber piled over this will soon become infected.

THE ARCHITECT AND CONTRACTOR

In not all cases of construction, particularly of residences, is an architect employed, the contractor sometimes assuming the architect's duties. No matter who it is that may be charged with the design, however, that person must ultimately accept the responsibility for employing the correct procedure in avoiding future development of dry-rot. His responsibility must start when the plans and specifications are drawn, and he must see to the proper inspection of materials to determine their freedom from dry-rot. The contractor, in any case, is obligated to carry out the construction details agreed upon and to perform his part in a workmanlike manner. It is also his duty to prevent any acts of negligence on the part of his employees which may lead to the development of dry-rot.

If builders would recognize more generally that timber cut

from trees containing much sapwood should not be used for basement or first-floor construction unless properly treated with a wood preservative the property-owner's interest would be greatly safeguarded. Even the best grades of pine, cypress, and other softwoods may fail when improperly used. In fact the lower grades of stock may be made more durable than untreated heartwood by suitable impregnation with an antiseptic.

With a wider knowledge of certain fundamental requirements for the control of dry-rot, infection in buildings can be reduced to a low minimum by careful attention to construction details. The necessary modifications of current practices are easy to carry out.

POINTS OF DANGER

An analysis of the cases upon which we have suitable records indicates the following points of danger:

1. Insufficient ventilation beneath the ground floor.
2. Improper excavation, leaving certain of the foundation timbers in contact with the soil.
3. The use of wood posts placed directly on the ground for the support of the building.
4. Failure to remove wood forming from concrete work after the job is completed.
5. Failure to remove all odds-and-ends of woody debris which are present or may accumulate beneath the building during construction.
6. The use of wood flooring on top of concrete slabs in basements without first protecting the timber with a wood preservative.
7. Leaks from roofs, from plumbing, around windows and doors, seepage through stucco, etc., which may allow water to collect and run down toward the foundations.
8. The use of infected timber or other builder's supplies, either during original construction or in making repairs or alterations.

In considering these points one should keep four fundamentals in mind: (1) That the soil apparently harbors the dry-rot organism; (2) that moist conditions cause it to develop; (3) that regardless of ventilation any timber which forms a direct connection from the ground to the building will permit the fungus to pass upward; and (4) that on account of the prevalence of the dry-rot fungus in lumber yards the possibility of introducing it into buildings through lumber and other supplies is far from remote.

Ventilation.—Ample ventilation is the best insurance against dry-rot. In case moisture collects beneath the building from any cause proper ventilation will soon remove it during warm dry weather and the conditions for fungus infection and devel-

opment will be rendered less favorable. Various types of ventilators are put in foundation walls, but modern construction tends toward the use of small openings and iron grills. Sometimes, particularly around porches, they are entirely omitted. In other cases ventilation is provided in brick walls by latticing the brick in certain areas, and frequently in the older buildings resting on brick piers wood lattice is used between the piers (Fig. 12). It is necessary in all cases to have ventilators sufficient in number and size to insure cross ventilation from every direction in order to keep the air beneath the building as dry as that on the outside. It is better to err in favor of ventilation than against it. Openings 12 by 18 inches spaced 6 to 8 feet apart entirely around the building would normally be sufficient. It should be kept in mind, however, that many of the heavy ornate iron grills are not more than 50 percent effective and the simpler types with a maximum of air space between the bars are to be preferred.

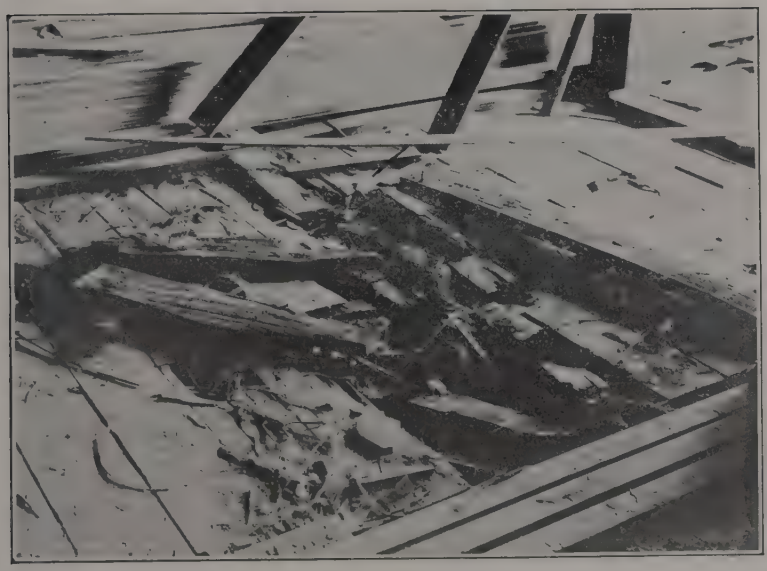

Fig. 4. Floor in a lumber shed completely dry-rotted.

Improper Excavation.—Very often excavation is required and frequently this is insufficient. There should be at least 18 to 24 inches between the earth and the bottom of the timbers. Where a structure is built against a hill-side area ventilators are essential in order to take care of any possible dead air spaces. The areaways should have walls sufficiently high to

keep out surface drainage, and tile drains could advantageously be put at the bottom to carry away any water which might enter during heavy rains.

In a number of the rot cases investigated the origin of the outbreak has been traced to insufficient excavation at some point without suitable provision for ventilation. The situation is sometimes aggravated by throwing earth up around the sills and joists.

Porches have been one of the principal points of danger. Those constructed of masonry or concrete are now in considerable favor. The floors of this type usually consist of a concrete slab, which is often tile surfaced. In many instances the slab is placed directly on earth which makes contact also with the front sill of the house. This practice has almost invariably led to trouble. In the first place it cuts off all ventilation through the front foundation wall; secondly, it invites disaster by placing timber in contact with soil which is probably infected with fungi.

Front sills will sometimes rot merely from contact with cement. This is occasionally provided against by flashing the sill with tin and one firm of architects in Montgomery improves upon this by placing thin blocks of redwood between the piers or foundation wall and the sill and setting the sill back for perhaps half an inch so as to get air circulation entirely around it. In one case of ordinary rot which developed in a sill abutting a concrete porch the owner cut a narrow trench through the concrete and soil to somewhat below the replaced sill and filled this with tar.

The writers believe that the best type of concrete porch or veranda construction consists in complete excavation beneath the reinforced slab and plenty of ventilators in the porch foundations as well as through the foundation walls of the house. Wood sills abutting on the concrete can be fully protected by the application of a wood preservative. The preservatives to use and the methods of application will be discussed later.

Wood Posts for Foundations.—Wood posts should never be used for foundations unless *thoroughly impregnated* with a good wood preservative or unless placed on concrete or brick piers 6 to 8 inches above the ground level. Even in the latter case it is advisable to treat them. A number of instances have come to attention where untreated wood in contact with the soil has been the direct cause of severe outbreaks of dry-rot. We will cite one of these to illustrate what will happen if this practice is followed.

A bungalow in central Alabama, constructed entirely of wood, was reported to be in a dangerous state of decay. On inspecting the property it was found that the outbreak had come through the floor and had run up the interior partitions, as well as the outside walls, for at least 12 feet. The house was built entirely of timber cut from the surrounding forest. The in-

terior was ceiled with lumber throughout. Following a customary practice, the house was set on green, peeled, heart longleaf pine posts 16 to 30 inches in diameter and 2½ to 3 feet high, placed on plank footings directly on sandy soil (Pl. III, Fig. 1). The siding of the exterior extended only to the top of the posts, leaving complete ventilation beneath the building from all directions.

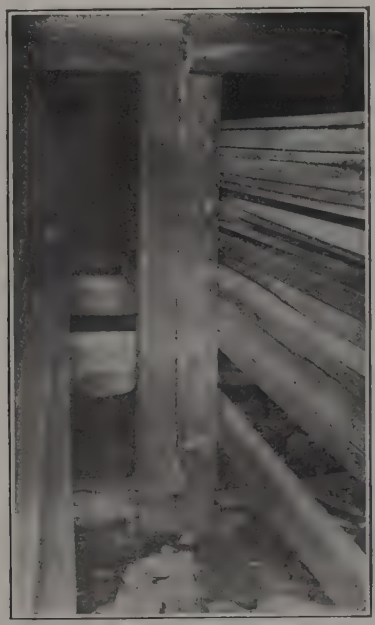

Fig. 5. Post in a retail lumber shed thoroughly infected with dry-rot and showing fruit-bodies of *Poria incrassata* running to the top. Infection will be transmitted in the course of a few days to the sound stock piled against it.

Since the timber was cut and sawed locally it was only partially seasoned when used and in order to dry it further the ceiling lumber was not applied until some time after the frame was up and the building enclosed. Under the circumstances it thus appears that the infection originated on the building site, and working on this assumption the foundation posts were carefully examined. On the surface they appeared to be in fairly good condition, but on tapping with a hatchet they sounded quite hollow. A number of them were chopped into and in many instances the inside was found thoroughly rotted (Pl. III, Fig. 2). This demonstrated quite clearly that the dry-rot fungus had entered the building from the infected soil.

Failure to Remove Wood Forming.—Through negligence on

the part of the contractors concrete forms are sometimes left in position. This is a very dangerous oversight which will almost invariably cause trouble when such timber is left in poorly ventilated spaces. If in contact with the ground it furnishes a path for dry-rot fungi to pass upward from the soil, and even if away from the ground the wet concrete keeps the wood in a moist condition for a long time, and thus readily susceptible to rapid decay.

Three cases, out of several investigated, will illustrate. In a fine residence the porch foundations and columns were constructed of stone with no provision whatever for ventilation. The floor consisted of tile over a concrete slab several feet from the ground. The forming, which was left in, acted as reinforcement for a time but soon completely disintegrated from dry-rot. The floor then began to sag and at the time of the inspection showed a large crack extending for almost the entire width (Pl. III, Fig. 3). From the forming the fungus passed to the sills and subfloor timbers of the home causing further damage and much anxiety.

The second instance was that of an old frame church removed to a new location. In remodelling, the floor of the wood veranda was changed to concrete and tile. Instead of tearing out all the old joists and making a properly reinforced concrete slab the builders left the old timbers in and poured the concrete around them. In a short time the floor collapsed following a service. Fortunately the accident took place after most of the congregation had passed out and the only victim was a lady who suffered severe injury to the lower part of the body. At the time the writers inspected the building, a year or more after the collapse, it was found that extensive repairs had been made throughout the flooring and lower walls of the main portion of the structure, indicating a generalized infection with dry-rot.

The other case deserving mention at this point is that of a fine Colonial home in southeastern Alabama which was raised about three years ago. Recently the owners called in the junior writer to make a dry-rot inspection. It was found that the contractor who raised the building had left one of his wood blocks in position to support a sill beneath the porch. The fungus had run up this block to the building and had spread through the floors and up the walls to the second story, where dense mats of the growth were found under the linoleum in the bathroom.

Wood Debris Beneath the Building.—Since wood in contact with the soil may soon become infected with dry-rot it is imperative that every bit of such material be removed from beneath the building on completion of the job. At least one instance is known in a southern state where failure to attend to this resulted in a severe outbreak. In the case alluded to all the accumulated odds and ends cut from lumber during the course of construction were conveyed to the last room floored.

The litter was there dumped beneath the building and reliable reports indicate there was a sufficient quantity to form a pile extending up to and around the floor joists. This rubbish heap started a general outbreak which involved many hundred square feet of floor and supporting timbers and entailed a heavy repair bill.

Wood Flooring on Concrete or Brick Laid on the Ground.—A number of instances have been observed where wood flooring has rotted when placed over concrete or brick placed on the ground (Pl. III, Fig. 6). The trouble is more likely to occur in excavated basements, where seepage is usually greater than at ground level. The usual methods for water-proofing cement have frequently proved ineffective in keeping the timber dry and the only sure procedure is to impregnate both the nailing strips and subfloor with a suitable antiseptic.

Leaky Roofs, Plumbing, Etc.—In a few cases dry-rot outbreaks can be traced to occasional wetting of the timber from various causes. Sometimes the water may come from the eaves, particularly where built-in gutters are installed, sometimes from

Fig. 6. The posts in this lumber shed were rotted off by the dry-rot fungus and then spliced.

leaks or breaks in water pipes, sometimes, perhaps, by way of leakage around casement windows, and in one case an outbreak was probably initiated by rain entering through the flat top of an ornamental stuccoed boxed column which was not protected from the weather by flashing or other covering.

Use of Infected Building Materials.—We have already shown that dry-rot infections are widespread in storage sheds for lumber and other building supplies. Frequently considerable quantities of stock are affected. When it becomes so badly decayed as to be unsalable, which may be the case in two to three months (Fig. 9), the dealer usually culls it. If only slightly infected, however, it is not infrequently passed on to the consumer with or without subsequent dressing. The fungus is difficult to detect in subsequently dressed stock since the characteristic sheets of yellowish white fan-shaped growth are removed. Such stock is just as dangerous to use as before, however.

The writers have seen badly infected stock frequently repiled with sound materials and sometimes it is used for structural purposes about the yard (Fig. 13). In three instances observed it has been employed in the construction of racks for new lumber and in one instance for fencing the premises. Since very few houses have been inspected during the process of construction the incorporation of infected timber has been observed in only one instance (Pl. III, Fig. 7).

It may be asked what bearing these facts have on the development and spread of outbreaks in buildings. In the opinion of the writers they stand in a very close causal relation to the epidemic character which the outbreaks are assuming, for every piece of timber infected with dry-rot that gets into a building may ultimately ruin the structure in consequence of the further development of the fungus. With all the facts before us, we must conclude that the only safe method for the builder to employ to insure absolute freedom from dry-rot in his materials is to order them from dealers who have no trace of the infection on their premises.

HOW TO ERADICATE DRY-ROT FROM BUILDINGS

We have already mentioned the root-like or vine-like growths which are frequently found beneath the first floor. Since these carry water upward from the ground to the timber no amount of increased ventilation will be of any value so long as they are operating. A very careful inspection should therefore be made beneath the building and whenever these firm, fibrous, often irregular, dirty-whitish to brownish growths, sometimes up to 3 or more inches thick, are found they should be removed and burned. When traced upward into the building they will be found to lead to the worst areas of decay. Sometimes they are in very obscure places and difficult to locate.

Just how much the development and spread of the rot will

Fig. 7. Dry-rot in an old pile of pine lumber in a discontinued shed in southern Alabama.

be retarded by breaking these water connections is not known, but such evidence as we have indicates that this alone will not hold the fungus in check. Such being the case the only positive remedy is to *tear out and burn every trace of decayed or infected timber.* With the usual out-breaks this means subfloor timbers, flooring, and sometimes entire walls for a considerable height, occasionally to the ceiling. During the work one will often find the timbers dripping with moisture. We have a record where the whole lower story of a fine residence has required replacement. With the less advanced infections, however, the decay will not have advanced upward so far, and only the sills and lower portion of the walls may need to be replaced. Remember that any trace of fungus left in the building is a possible source for new development, and it is much better to be safe than sorry.

Since the infection may be difficult to see at the boundaries of the decayed area it is highly advisable to cut back at least two feet beyond the last visible signs.

All decayed wood should be taken from the house as fast as removed—it is infectious.

When ready for replacement see that previous errors in ventilation, excavation, and construction are remedied and that your new timbers are free of dry-rot. Then spray the old timbers adjoining the diseased area, as well as the nearby walls and ground, with a wood preservative. You are then ready for the new timber which, after framing wherever possible, should be soaked in preservative before use. Wherever timber is sawn or notched after such treatment new preservative should be added hot with a brush. A discussion of methods and preservatives to use will follow.

HOW TO FREE LUMBER YARDS OF DRY ROT

Unless the lumber dealer can establish a clean bill of health the public is fully justified in viewing his products with skepticism. He should learn to recognize the fungous plague in all its phases and to take as energetic action against it as he would against small-pox, yellow fever and other contagions which if unchecked soon run into disastrous epidemics.

The first necessity is a thorough inspection of all lumber yards and other structures used for the storage of building materials in the State. This should be made by trained inspectors in the employ either of the Federal Government, the State or the lumber dealer's associations. Some dependable certification method could thus be established and by regular inspections timber products could be maintained in a sanitary condition.

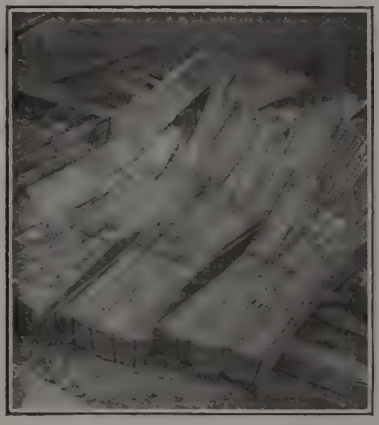

Fig. 8. A few bundles of cypress shingles out of many which became dry-rotted in storage.

The dealer must bear in mind, however, the possibility of getting infected shipments from outside sources and should be prepared to recognize and report any such infected material.

The destruction of infected material or its complete sterilization by heating in a suitable dry-kiln or other apparatus in the presence of an authorized inspector, should be insisted upon.

In case the fungus is already present in stock sheds it must be exterminated by removal and burning of all infected foundations, floors, posts, etc., and their replacement with sound durable heart stock, or sap stock treated with a preservative. All new construction or alterations should be so designed as to leave full cross ventilation beneath foundations or floors. Wood floors or foundation timbers should be supported on concrete or masonry piers, unless it is desired to use creosoted blocking treated by a pressure process. If it is desired to place wood flooring on the ground the lumber used should be very thoroughly impregnated with a wood preservative. Concrete, of course, makes an excellent floor. One large lumber company in southern Alabama has remedied a severe outbreak in one of its sheds by laying a concrete base surfaced with creosoted wood block. This is a permanent and highly effective type of construction.

PRESERVATIVE TREATMENT OF BUILDING TIMBERS

Wood preservatives applied to timber poison the food supply of the fungi. The effectiveness of any treatment depends upon the substance employed and the penetration secured. The two substances in general use are coal tar creosote and zinc chloride. Mercuric chloride (corrosive sublimate), sodium fluoride, and several others are also used to some extent.

Coal tar creosote is a black to brownish oily substance practically insoluble in water. It is highly effective against both

Fig. 9. Dry-rotted planks broken in handling, after about 3 months storage close-piled in a lumber shed.

fungi and white ants and is repellent to other insects and animals.

For the small consumer creosote is marketed in quantities as small as a gallon. The price varies widely according to grade, distance shipped, size of container, etc. Gallon lots sometimes retail as high as $1.25. Barrel shipments ordinarily sell for 60 to 75 cents per gallon, or less.

There are a number of creosote products on the market primarily designed for shingle stains. These are not recommended for the preservation of building timbers.

Zinc chloride is a widely used water-soluble preservative which gives a colorless solution. It is ordinarily used in a 2 to 5* percent solution, depending upon the method of treatment employed. Where timber is subjected to moisture it may leach from the wood to a certain extent, so creosote is usually preferred in such circumstances.

Fig. 10. Window sash which became infected with dry-rot from contact with a rotten warehouse floor.

Mercuric chloride (corrosive sublimate) has been used for many years in treating timber, with very good results. It has not come into general use in the United States, however, on account of two serious drawbacks. *It attacks metals and is poisonous to handle.* Therefore, it cannot be put in metal vats and workmen should use rubber gloves and carefully guard their operations. It is generally used in a 1 percent water solution.

Sodium fluoride is a colorless preservative of comparatively

* 5 pounds of chemical to 11½ gallons of water makes a 5 percent solution.

recent introduction. It is highly efficient and fairly cheap. It is soluble in water and is applied in a 3½ to 4 percent solution. It is safe to handle and is one of the best substances for treating interior finish which must later be varnished or painted.

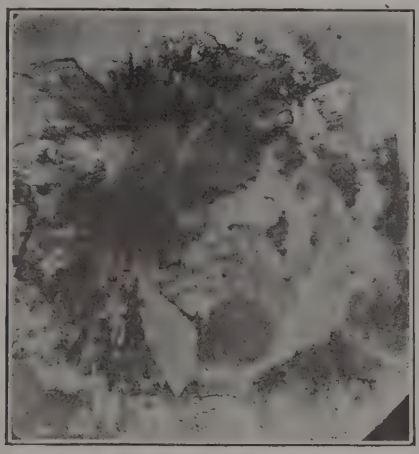

Fig. 11. Cement-asbestos shingle warped and discolored by the dry-rot fungus after a few weeks' contact with a decayed cypress floor.

METHODS OF APPLYING WOOD PRESERVATIVES

There are four standard methods of applying wood preservatives:

In *pressure treatments* the preservative is forced into the wood under pressure in closed cylinders. This process is the best. The method has the advantages of speed in operation and a relatively deep penetration, and its use is desirable when conditions permit.

There are many wood-preserving plants which treat with creosote and zinc chloride by the pressure process, but unfortunately small special orders are usually not readily filled. Information regarding these plants can be secured by addressing the Service Bureau, American Wood Preservers' Association, 1146 Otis Building, Chicago, Illinois, or the Forest Products Laboratory, Madison, Wisconsin.

The Hot-and-Cold-Bath Treatment is next in general effectiveness to the pressure treatment. With sap pine practically as good protection can be secured by this method as by pressure, especially if the timber be dry. The treatment consists in heating the wood in an open tank of the preservative for several hours then quickly submerging it in cold preservative or leaving it to cool in the original bath. Heating the timber in the preservative, without subsequent cooling therein is not usually sufficient. In heating, the object in view is to expand and drive out

the air in the wood. Upon cooling, the rarefied air that is left contracts and produces a suction which draws the preservative into the timber.

Where pressure-treated wood is not obtainable, or where the builder prefers to treat his own stock, the hot-and-cold-bath process should be used for sub-floor timbers as well as for nailing strips and rough flooring to be laid over concrete or brick resting on the ground. When coal tar creosote is used the temperature of the hot bath should be maintained at 190 degrees to 200 degrees Fahr.; higher temperatures will cause increased losses by evaporation. When water solutions are used they should be kept near the boiling point and the tank covered. It will be necessary to add water from time to time to replace that which evaporates.

For creosote a metal tank or a wood tank lined with metal should be used. An unlined wood tank will leak when used with this substance. For the water-soluble preservatives (except mercuric chloride, which corrodes metal) either wood or metal can be used. Metal tanks allow of heating by means of a fire beneath; wood tanks require the installation of heating coils.

The period of time allowed for the hot and cold baths must be governed by the ease with which the timber takes the treat-

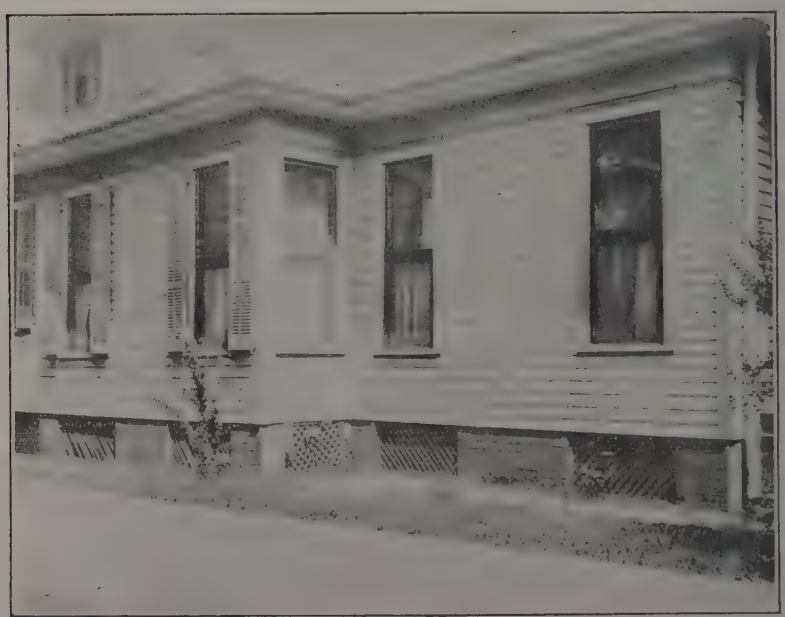

Fig. 12. Type of lattice ventilators in common use under the older residences in Selma.

Fig. 13. Dry-rotted plank used for constructing rack for new stock in an Alabama lumber shed.

ment. Sap pine and other woods moderately easy to treat should not require a hot bath of more than 2 to 3 hours and a cold bath of like duration.

After treatment creosoted timbers should be allowed to surface-dry, while those treated with water solutions should be allowed to season before use.

The Steeping Process is a step lower than the hot-and-cold bath in effectiveness. It can be used where large amounts of preservative are unnecessary, or where time is not an important consideration. The well-seasoned timber is merely soaked in a cold solution of a water-soluble salt. Mercuric chloride is the preservative which has most generally been used, in which case the process is known as "Kyanizing"; zinc chloride and sodium fluoride are just as well adapted, however. The duration of the steeping treatment is determined by the size of the timber, the wood being allowed to soak one day for each inch in thickness, plus one day more for good measure. Since no heating is employed the penetration of the preservative will be comparatively slight, and as a protection against decay this method will naturally be less effective in moist situations than others giving deeper penetrations.

In building construction the steeping process seems particularly adapted to the thinner stock, such as interior trim,

when used in dry places where only a moderate degree of protection is desired.

The simplest of all the treatments consists in *dipping the dry timber in hot creosote* for ten to fifteen minutes, or applying the oil with a brush or spray. Such treatment does little more than sterilize the surface. In buildings in process of repair the brush or spray method is of course the only one feasible for timbers left in position adjoining infected areas. Brush or spray can also be used to advantage in treating the masonry and soil beneath infected buildings.

COST OF PRESERVATIVE TREATMENTS IN BUILDINGS

With both labor and material costs varying for different regions it is impossible to establish definite cost figures for the different methods of treatment; but they will, in general, be found relatively cheaper in the order here presented.

Pressure treatmentts with coal tar creosote may add, in some instances, from $30 to $40 per thousand board feet to the cost of the timber. A recent quotation for a 6 lb. Rueping treatment, f. o. b. treating plant, was $18. Zinc chloride treatment may cost in the neighborhood of $20, or less.

With the hot-and-cold-bath process the cost may be somewhat lower.

The entire cost for treating the necessary timbers of a residence is comparatively small. A building which has 3,000 to 4,000 board feet of timber in the subfloor and floor supports would, at a price of $25 per thousand feet for the treatment, require an additional expenditure of only $75 to $100 to properly safeguard the structure. About the least to be expected if dry-rot gets into an untreated building will be a repair bill of from $300 to $500. From the standpoint of protection alone the added expense of preservation then becomes the cheapest insurance a builder can take out in the South today.

Whenever it is desired to paint or spray creosote on timbers in position they should be given at least two coats of hot preservative, with sufficient time intervening for the material to soak in. With water-soluble preservatives it is not so necessary to heat the solution. The object is to get as much preservative as possible into the wood. With creosote one gallon should cover approximately 100 square feet of surface, applying two coats.

It is impossible to over-emphasize the necessity of applying preservative to *any cuts made in timber after treatment,* unless the timbers happen to be thoroughly impregnated where the cuts are made. Wood preservatives protect only so far as they penetrate.

PLATE DESCRIPTIONS

Plate I

Fig. 1. Typical fruit body of *Poria incrassata* on the underside of pine flooring in a warehouse.

Fig. 2. Part of a fruit body of *Poria incrassata* from beneath a floor in a lumber shed. The lower figure is of a cross section, showing the tubes.

Fig. 3. Mycelium of *Poria incrassata* on the face of Douglas fir stepping stored over on infected floor in a Washington lumber shed. The fungus ran up the end-piled stock for about 4½ feet.

Fig. 4. Imperfectly developed fruit body of *Poria incrassata* on the upper surface of a pine floor in a cotton warehouse.

Fig. 5. Orange mycelium of *Poria incrassata* developing on a floor in a roofing warehouse in eastern Texas. Three successive untreated floors have been laid in this building. Had the first one been treated with a wood preservative no dry-rot would have occurred.

Fig. 6. Fruit body of *Poria incrassata* on the exposed surface of pine ceiling in an outbuilding.

Fig. 7. The same fungus fruiting in the back of the boards within the wall.

Fig. 8. A young fruit body of *Poria incrassata* from the partially illuminated basement of a building in Washington, D. C.

Fig. 9. Spores of *Poria incrassata*—greatly magnified.

Fig. 10. Water-conducting strands on the under side of the pine flooring laid over brick shown in Plate III, Figure 6.

Plate II

Fig. 1. Root-like water-conducting growths of *Poria incrassata* showing their method of attachment to the soil. The board was taken from beneath a cupboard in the basement of a University building at Baton Rouge, Louisiana. It was very close to the ground. Note how the fungus "roots" have spread out at the surface of the soil. The infection starting at this point ran up to the second floor and necessitated extensive repairs.

Fig. 2. Destruction caused by *Poria incrassata* in a display window of a small store. The store floor was of concrete. All the enclosed woodwork beneath the display platform was rotted out, due to seepage, and lack of ventilation.

Fig. 3. A case of dry-rot in a south Alabama bungalow. The wainscoting in this panel appears sound on superficial inspection but on removal was in the condition shown by the two pieces of lumber reversed. Figures 4 and 5 illustrate other features of the case.

Fig. 4. A view of the wall after most of the wainscoting, as well as some of the ceiling, have been removed. The fungus extended up the studding for about 6½ feet. It entered the building by means of a small strip of lumber which extended from the ground into the wall at the lower left corner of the picture.

Fig. 5. Condition of the floor in the same corner of the room. This was originally broken through by a bed post and the hole then was enlarged to permit inspection beneath the house. The white portion represents sheets of the fungous mycelium exposed by stripping away the top floor.

Plate III

Fig. 1. Heart pine posts placed in a green condition to support a bungalow. The dry-rot fungus entered these posts from the soil, rotted out their centers and spread up the partition walls of the building for at least 12 feet.

Fig. 2. A close-up of one of the posts chopped into to expose the rotten interior.

Fig. 3. Tile surfaced porch floor showing a large crack due to the rotting out of the forming left in position beneath.

Fig. 4. An interior wall of pine ceiling in a bungalow. The white lines show the location of shrinkage cracks through which the white mycelium is exposed.

Fig. 5. The same view as shown in Figure 3 after a few sections of boards have been removed to show to better advantage the sheets of mycelium on the timber behind. These sheets extend the entire height of the wall.

Fig. 6. Dry-rotted pine floor laid over brick in the basement of a church. A new floor would not last more than a year or two unless treated with a wood preservative.

Fig. 7. First floor joist infected with *Poria incrassata* recently placed in a fine new home in process of construction. This demonstrates that timber infected with dry-rot sometimes gets into buildings through the use of lumber secured from unsanitary yards.

PLATE I. *Poria incrassata*

PLATE II. *Poria incrassata*

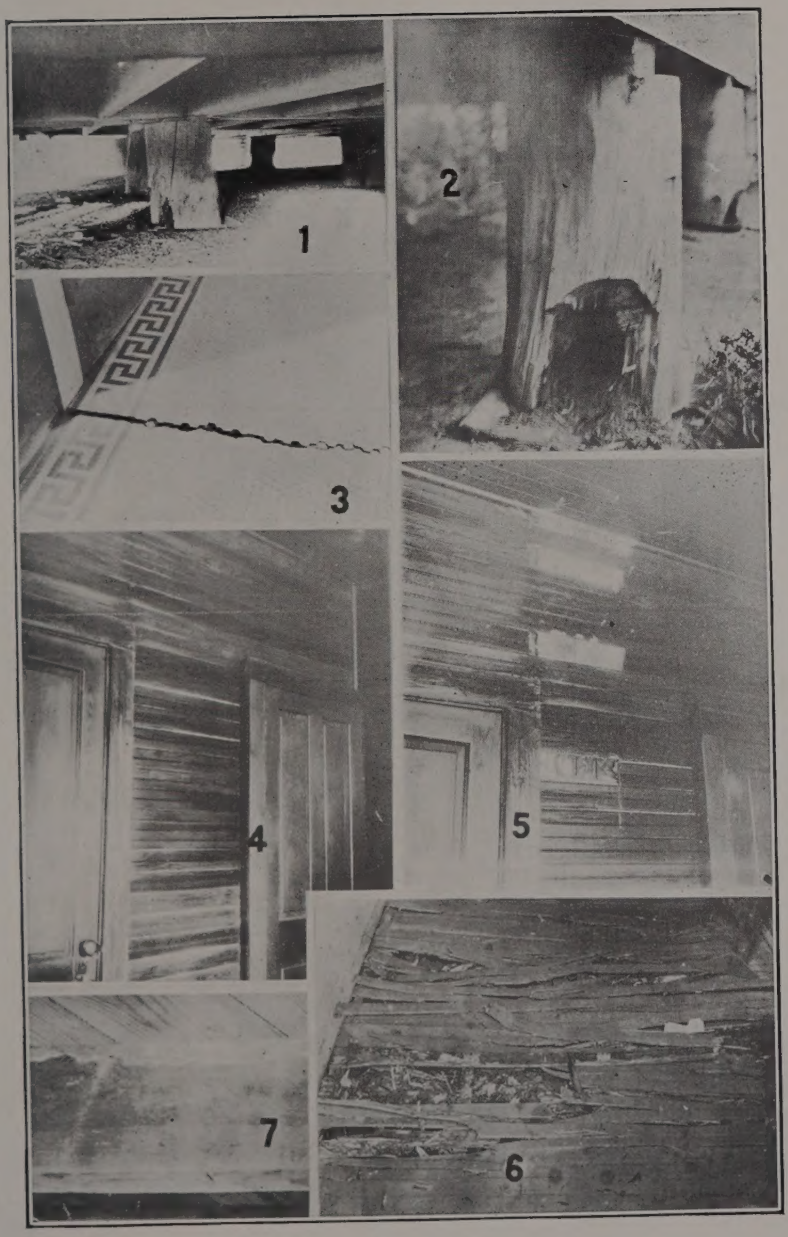

PLATE III. *Poria incrassata*